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ANDERSON ENGINEERING INC SPRINGFIELD MO
NATIONAL DAM SAFETY PROGRAM. HOUGH PARK DAM (MO 30022), MISSOURI--ETC(U)
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COLE COUNTY, MISSOURI
MO 30022

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PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
FOR: STATE OF MISSOURI

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Hough Park Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Hough Park Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

The St. Louis District has classified this dam as unsafe because of heavy tree growth on the downstream face, and excessive seepage through the dam.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

16 MAR 1979

Date

APPROVED BY:

SIGNED

Colonel, CE, District Engineer

19 MAR 1979

Date

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HOUGH PARK DAM
COLE COUNTY, MISSOURI
MISSOURI INVENTORY NO. 30022

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By
Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

For
The Governor of Missouri

December, 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Hough Park Dam
State Located:	Missouri
County Located:	Cole County
Stream:	Unnamed Tributary to Moreau River
Date of Inspection:	23 August 1978

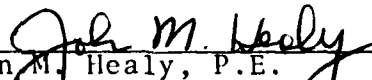
Hough Park Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.


The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam has been classified by the St. Louis District Corps of Engineers as an intermediate size dam with a high downstream hazard potential. Their estimate of the damage zone extends 4 miles downstream of the dam. Within the damage zone are two houses and the Lincoln University farm complex which includes eleven buildings and five silos. The floodplain is farmed.

~~Our~~ inspection and evaluation indicated that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 47 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of intermediate size with a high downstream hazard potential pass 100 percent of the PMF. The combined spillways will pass the 100-year flood without overtopping.

The embankment was covered with trees and brush, which should be removed. Minor erosional areas were noted and should be corrected. The major concern was the seepage which was noted on the downstream face of the dam below approximate elevation 126, particularly between stations

2+15 and 3+50. Further investigation of this condition is recommended after the embankment is cleared. Another deficiency was the lack of seepage and stability analyses comparable to the guidelines. A detailed report describing these deficiencies is attached.


John M. Healy, P.E.
Hanson Engineers, Inc.


Steven L. Brady, P.E.
Anderson Engineering, Inc.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
HOUGH PARK DAM - ID No. 30022

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Hough Park Dam in Cole County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Hough Park Dam is an earth fill structure approximately 46.5 ft high and 585 ft long at the crest. The appurtenant works consist of a concrete drop inlet and corrugated metal pipe primary spillway, which is located at the west abutment of the dam, and an earth and rock emergency spillway, which is located at the east abutment. Sheet 4 of Appendix A shows a plan of the embankment and spillways and a typical section of the embankment.

B. Location:

The dam is located in the northeast part of Cole County, Missouri on a small tributary of the Moreau River. The dam and lake are within the Jefferson City, Missouri quadrangle sheet, one mile south of Jefferson City (SW 1/4 Section 19, Twp. 44 N, R 11 W-latitude 38° 32.4'; longitude 92° 11.0').

Sheet 1 of Appendix A shows the general vicinity and location of the dam. Sheet 2 shows a plan of the immediate area of the dam and lake.

C. Size Classification:

With an embankment height of 46.5 ft and a maximum storage capacity of approximately 183 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. Their estimate of the damage zone extends 4 miles downstream of the dam. Within the damage zone are two houses and the Lincoln University farm complex which includes eleven buildings and five silos. The floodplain is farmed.

E. Ownership:

The dam is owned by the Jefferson City Park Board and was designed by P. S. Thomas, who now holds the position of Cole County Engineer. The Jefferson City Park Board offices are located at 1203 Missouri Boulevard, Jefferson City, Missouri 65101.

F. Purpose of Dam:

The dam was constructed primarily for recreational purposes.

G. Design and Construction History:

Construction of the dam was completed in 1965. Design plans are available and have been used to prepare this report. The Park Ranger indicated that the downstream face has been damp since the dam was constructed. No modifications are reported to have been made to the dam.

H. Normal Operating Procedure:

Normal flows will be passed by an uncontrolled drop inlet spillway, whereas an earth and rock emergency spillway would come into operation for major floods.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 4 of Appendix A is a plan of the embankment and spillways with a typical cross section of the dam.

A. Drainage Area:

The drainage area for this dam, as obtained from the Jefferson City, Missouri 7 1/2' quad sheet, is equal to approximately 90 acres.

B. Elevations (Site Datum):

- (1) Top of dam (measured): East end 140.3; Center 139.5; West end 141.0.
Top of Dam (Design Plans): 139.5.
- (2) Principal Spillway Crest: Design Plans 135.0.
- (3) Emergency Spillway Crest: Design Plans 137.5; measured 137.5.
- (4) Primary Spillway Outlet Pipe Invert: Design Plans 93.0; measured 92.8.
- (5) Pool on Date of Inspection: Measured 135.0.
- (6) Apparent High Water Mark: 137.0 (1973-Date Unknown).
- (7) Streambed at Centerline of Dam: Design Plans 96.0.
- (8) Maximum Tailwater: Unknown.

C. Discharge at Dam Site:

- (1) All discharge at the dam site is through uncontrolled spillways.
- (2) Estimated Discharge Capacity of Principal Spillway at Top of Dam (El. 139.5): 9 cfs.
- (3) Estimated Total Discharge Capacity at Top of Dam (El. 139.5): 264 cfs.
- (4) Estimated Experienced Maximum Discharge (El. 137.0-1973): 7 cfs.

D. Reservoir Surface Areas:

- (1) At Principal Spillway Crest: Design Plans 11.4 acres.
- (2) At Emergency Spillway Crest (Estimated from Design Plans): 12.8 acres.
- (3) At Top of Dam (Estimated from Design Plans): 13.8 acres.

E. Storage Capacities:

- (1) At Principal Spillway Crest: 126 acre-ft.
- (2) At Top of Dam (El. 139.5): 183 acre-ft.

F. Reservoir Lengths:

- (1) At Principal Spillway Crest (Estimated from Design Plans): 1500 ft.
- (2) At Emergency Spillway Crest (Estimated from Design Plans): 1560 ft.
- (3) At Top of Dam (Estimated from Design Plans): 1600 ft.

G. Dam:

- (1) Type: Rolled earth.
- (2) Length at Crest: 585 ft.
- (3) Height: 46.5 ft.
- (4) Top Width: 18 ft.
- (5) Side Slopes: Upstream 3:1; Downstream 2.5:1.
- (6) Zoning: Homogeneous silts and clays.
- (7) Cutoff: Core trench into bedrock (Design Plans)

H. Principal Spillway:

- (1) Location: West abutment.
- (2) Type: 4 ft by 4 ft concrete overflow with a 12 in. diameter corrugated metal pipe through dam.

I. Emergency Spillway:

- (1) Location: East abutment.
- (2) Type: Grass covered earth (some bedrock exposed on east side) with a concrete control section as shown on Sheet 4 of Appendix A. The control section is actually slightly upstream of the concrete section (crest length at control is 28 ft as measured in field).

SECTION 2 - ENGINEERING DATA

2.1 GENERAL:

The only available report is a geology report by the Missouri Geological Survey which contains some shallow boring information (included as Sheets 1-4 of Appendix B of this report). The Technical Specifications for the project are included as Sheets 5 through 14 of Appendix B. A discussion of Hydrology and Hydraulics design from the Missouri Conservation Commission is included as Sheet 15 of Appendix B. The Design plans contain a brief summary of hydrologic design data (Sheet 2 of Appendix A). No documentation of construction inspection records is available. There are no documented maintenance and operation data to our knowledge.

2.2 DESIGN:

A. Surveys:

The Design Plans show the topography of the lake and dam area (Sheets 2 and 4 of Appendix A). The overflow crest of the primary spillway was used as datum for this inspection (El. 135.0). Elevations at other pertinent locations checked reasonably well with the Design Plans.

B. Geology and Subsurface Materials:

The general geology of the area indicates a relatively thin mantle of loess and residual soils over bedrock in upland areas. Bedrock in the area is the Jefferson City dolomite which is considered by Missouri Geological Survey (MGS) personnel (see Sheets 1 & 2 - Appendix B) to be "relatively resistant to the effects of weathering and ground water solution."

The shallow hand auger borings made by the MGS in valley and valley wall areas encountered 2.0 ft to 3.5 ft of silt over a clay with gravel and some boulders. An average of 6 ft of soil cover was encountered.

No design computations are available. Borrow material for the dam was apparently obtained from core trenches, channel changes, roadway cuts and the reservoir area between elevations 100 and 135 (see Technical Specifications - Appendix B). The Technical Specifications indicated that the embankment materials should be compacted to 85 percent of the maximum dry density as obtained by the Modified Proctor Compaction Test. Conversations with Mr. Thomas, who designed the dam, indicated that he did not believe that any field density tests were taken during construction. There is apparently no particular zoning of the embankment, and no

internal drainage features are known to exist. The Design Plans indicate the existence of a core trench keyed into the underlying bedrock. No construction inspection records have been obtained.

D. Hydrology and Hydraulics:

Based on data from the Design Plans, a field check of spillway dimensions and embankment elevations, and a check of the drainage area on the U.S.G.S. quad sheet, a hydrologic analysis using the U.S. Army Corps of Engineers guidelines was performed and appears in Appendix C, Sheets 1 to 6. It was concluded that the primary and emergency spillways combined will pass 47 percent of the Probable Maximum Flood.

E. Structure:

Structural design computations for appurtenant structures were not obtained. Details of the spillway structure are shown on the Design Plans (see Sheet 3 of Appendix A).

F. Construction:

No construction inspection data have been obtained. The design engineer indicated that he was not aware of any field density testing done for the embankment.

2.3 OPERATION:

No particular operating procedures are used for this unregulated structure. The maximum height of water experienced appears to be approximately 2 ft above the primary spillway crest. The emergency spillway has apparently never been used. The Park Ranger indicated that the water in the lake is supplemented by a 900 ft deep well which exists on the west shore line. The well is used to water the golf course, and the overflow is discharged into the lake. No information was available on the quantity of water pumped into the lake from the well.

2.4 EVALUATION:

No design computations or construction records were available for this dam. Thus, the engineering data available were inadequate to make a detailed assessment of the design, construction, and operation.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 GENERAL:

The field inspection was made on 23 August 1978. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Roger Phillips - Anderson Engineering (Instrument Man)
Steve Brady - Anderson Engineering (Civil Engineer)
Jack Healy - Hanson Engineers (Geotechnical and Structural Engineer)
Gene Wertepny - Hanson Engineers (Hydraulics Engineer)

3.2 DAM:

The embankment is covered with trees and brush on both faces (especially heavy tree growth on downstream face). The majorities of the trees are 2 to 5 in. in diameter, with some up to 8 in. Some erosion was noted, particularly at embankment-abutment contacts.

The downstream face of the dam was damp between stations 2+15 and 3+50. The wet area starts 10 ft below the top of the dam and generally includes the entire face. The floodplain immediately downstream of the toe was wet and covered with cattails. No evidence of sloughing or piping was noted. However, due to the heavy tree and brush cover, it was difficult to evaluate this condition. The park ranger indicated that the downstream face has been wet since the dam was built.

The horizontal alignment appeared as constructed. No surface cracking or unusual movement was obvious. There was no visible rip-rap on the upstream face. No instrumentation (monuments, piezometers, etc.) was observed.

A. Primary Spillway and Outlet:

The inlet box was in good condition--no cracking or spalling of concrete was noted. The intake structure was surrounded by trees and brush.

The outlet structure and pipe was also in good condition. There was a heavy growth of trees and brush in the outlet channel area.

B. Emergency Spillway:

The emergency spillway is in good condition (has apparently never been used). It measures 28 ft in width (plans indicate 34.2 ft crest) with 3h: 1v side slopes. The base and side slopes of the emergency spillway are grass covered. The downstream channel is overgrown with trees and brush.

3.3 RESERVOIR AND WATERSHED:

The immediate periphery of the lake is heavily wooded with moderate slopes. No sloughing or serious erosion of reservoir banks was noted.

A large portion of the west and north portions of the drainage area is golf course. The east portion of the drainage area is heavily wooded.

3.4 EVALUATION:

In general, tree and brush growth on the dam should be cut and removed on an annual basis. The heavy overgrowth of trees and brush at the approach to the primary spillway and in the discharge channels of both the primary and emergency spillways should be removed and maintained. Erosional areas at dam-abutment contacts should be corrected.

The seepage on the downstream slope is difficult to evaluate in terms of its effect on embankment stability, due to the heavy growth of trees and brush. This condition should be evaluated thoroughly by a qualified engineer after the overgrowth is removed.

Photographs of the dam, appurtenant structures, and the reservoir and watershed are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam; therefore, no regulating procedures exist. The pool is controlled by rainfall, runoff, evaporation, seepage, and the capacities of the uncontrolled spillways. The water in the lake is supplemented by a 900 ft deep well used to water the golf course.

4.2 MAINTENANCE OF DAM:

Based on the amount of brush and the size of trees on the dam, it has been many years since the vegetation has been cut. Apparently, there is no regular maintenance of the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES:

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM AND AFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

Apparently, no particular operational or maintenance procedures exist for this dam. Tree and brush growth should be removed from the dam on a yearly basis. The approach to the primary spillway and the outlet areas of both the primary and emergency spillways should be cleared. Erosional areas at abutment-dam contacts should be repaired and maintained. The use of riprap to prevent future erosion in these areas is a possibility.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design and Experience Data:

Based on the information on the Design Plans, a field check of spillway dimensions and embankment elevations, and a check of the pool and drainage areas from the U.S.G.S. quad sheet, a hydrologic analysis using U.S. Army Corps of Engineers guidelines was performed and appears in Appendix C, Sheets 1 to 6.

B. Visual Observations:

The inflow structure and outlet pipe for the primary spillway appear in good condition. Both the approach and outlet areas should be cleared. The earth emergency spillway is in good condition. The outlet channel of the emergency spillway should be cleared. The emergency spillway has apparently never come into service.

No facilities are available to draw down the pool. The primary spillway is located on the west abutment, and the emergency spillway is located on the east abutment. Spillway releases would not be expected to endanger the integrity of the dam.

C. Overtopping Potential:

Based on the hydrologic and hydraulic analysis as presented in Appendix C, the combined primary and emergency spillways will pass 47 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass 100 percent of the PMF, without overtopping. The structure will pass a 100-year frequency flood without overtopping.

The routing of the PMF through the spillways and dam indicated that the dam will be overtopped by 0.68 ft at elevation 140.18. The duration of the overtopping will be 2.58 hours and the maximum outflow will be 1572 cfs. Fifty percent of the PMF will overtop the dam by .13 ft with a duration of overtopping of .42 hours and a maximum outflow of 511 cfs.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Visual observations which could adversely affect the structural stability of this dam are discussed in Sections 3.2 and 3.4. If left unchecked, tree growth and the erosion at abutment-dam contact areas could cause stability problems in the future. The main concern is the seepage through the dam between stations 2+15 and 3+50. This condition should be evaluated thoroughly after the embankment is cleared as recommended in Section 3.4.

B. Design and Construction Data:

No design or construction data relating to the structural stability of the dam were found. Our site inspection indicated that the side slopes and berm widths are as shown on the Design Plans. The Technical Specifications (Appendix B-Sheets 5 through 14) require that embankment materials be compacted to 85 percent of the maximum dry density as obtained by the Modified Proctor Compaction Test, ASTM D-1557. However, we were told by the designer that he was not aware of any field density tests being made during construction.

C. Operating Records:

No appurtenant structures requiring operation exist at this dam.

D. Post-Construction Changes:

To our knowledge, no post-construction changes have been made.

E. Seismic Stability:

The structure is located in seismic zone 1, which is historically the least active zone in terms of occurrence and magnitude of earthquakes. The seismic loading prescribed for zone 1 is generally not critical for a well-constructed earth dam of this size. However, considering the lack of field density control during construction and the possible weakened condition of the embankment due to seepage pressures, it is recommended that the prescribed zone 1 seismic loading be applied in the stability analyses recommended in Sections 2.4 and 7.2.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

A. General:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

B. Safety:

Several items were noted by the inspection team during the visual inspection which should be corrected or controlled. These items include seepage, trees and brush and some erosion at dam-abutment contacts. The extent of the seepage item can be better assessed after the trees and brush have been removed. The stability of and seepage conditions on the cleared downstream slope should be investigated and analyses made by an engineer experienced in design of dams.

The dam will be overtopped by flows in excess of 47 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure. The structure will pass a 100-year frequency flood.

C. Adequacy of Information:

The conclusions in this report were based on review of the Design Plans, the geologic report prepared by the Missouri Geological Survey, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

D. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If these items are not corrected and if good maintenance is not provided, the embankment condition will continue to deteriorate and it could become serious in the future.

E. Necessity for Phase II:

The recommended further investigation of the seepage and stability conditions discussed in Section 7.2 is considered absolutely necessary and should be accomplished by the owner in the near future. A Phase II inspection is not recommended.

F. Seismic Stability:

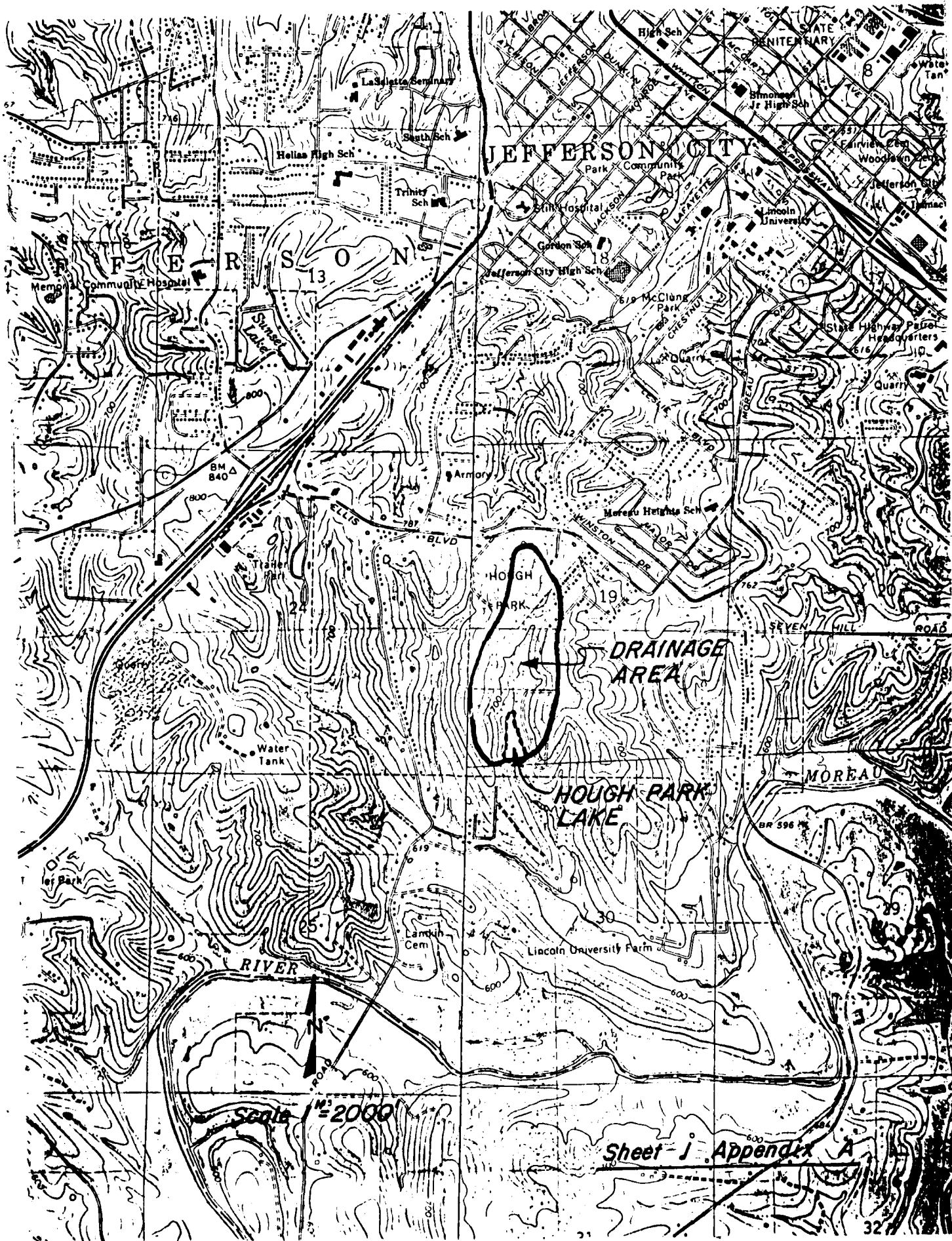
The structure is located in seismic zone 1, which is historically the least active zone in terms of occurrence and magnitude of earthquakes. The seismic loading prescribed for zone 1 is generally not critical for a well-constructed earth dam of this size. However, considering the lack of field density control during construction and the possible weakened condition of the embankment due to seepage pressures, it is recommended that the appropriate earthquake loads be applied in the seepage and stability analyses as recommended in Section 2.4.

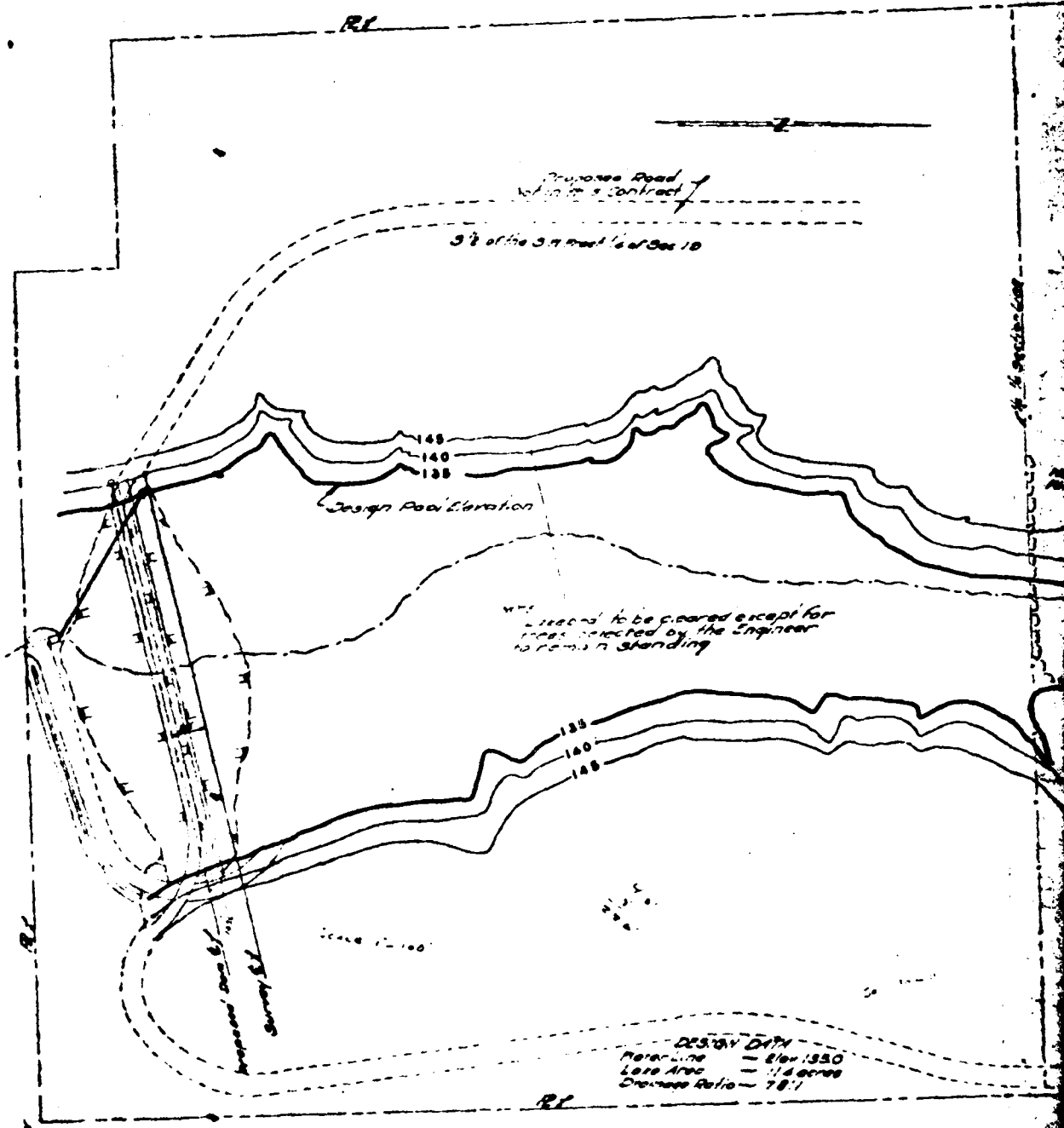
7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended and should be supervised by a professional engineer experienced in the design and construction of dams:

- (1) Tree growth on the upstream and downstream slope of this dam is considered a deficiency. These trees should be removed under the guidance and direction of competent engineering supervision. Indiscriminant clearing methods could jeopardize the safety of the dam. Cut the trees and brush around the entrance to the primary spillway to prevent restrictions. The outlet areas for both the primary and emergency spillways should be cleared.
- (2) Correct the minor erosion activity at embankment-abutment contacts and place riprap in these areas to minimize erosion in the future.
- (3) The seepage condition on the downstream slope should be investigated thoroughly after the slope is cleared. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams. The results of these analyses should be used to design appropriate corrective measures.
- (4) A detailed inspection of the dam should be made at least every 5 years by an engineer experienced in the design and construction of dams. More frequent inspections may be required if slides, seeps, or other items of distress are observed.

APPENDIX A





SUMMARY OF QUANTITIES

2

ITEM NO.	DESCRIPTION	UNIT	QTY	REMARKS
1-A	Clearing	L.S.	1	
1-B	Earth Fill	Cu Yd	24,200	
2-A	Driveway Pavement (Reinforced)	Sq Yd	84.8	
2-B	Class 3 Conc. etc.	Cu Yd	84.8	Base & Cullers
2-C	Reinforcing Steel	Lb.	488	Base & Cullers
3-A	18" C.M. Pipe	Lin Ft	88.6	
4-A	Furnishing & Setting Pipe Rep	Cu Yd	10	
5-A	Trash Barrier	L.S.	1	Face of Parkway side

Out Course

No. 14
Pavement

No. 14
Pavement

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Sheet 2
Appendix A

Proposed Road
not in this Contract

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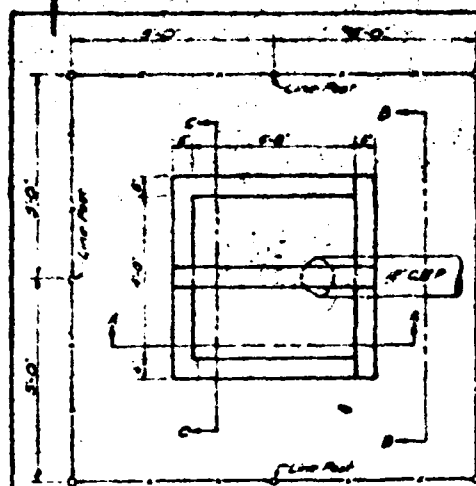
HOUGH PARK LAKE

JEFFERSON CITY PARK ROAD
JEFFERSON CITY, MISSOURI

GENERAL LAYOUT

AS SHOWN

Contracting Engineer - Jefferson City, Missouri
Date: 1966
10-63 1/100



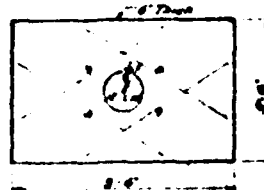
PLAN-INLET

1/2" x 1/4" x 10'-0" Steel Corrosion Rod with Cap, set in 2'-0" of concrete

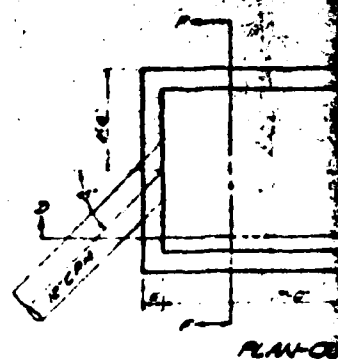
2" x 4" x 10'-0" Steel Plate, 1/4" Thick

2" x 4" x 10'-0" Steel Plate, 1/4" Thick

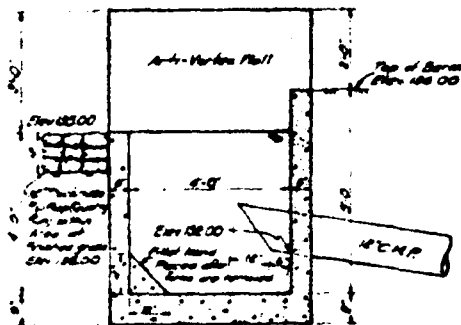
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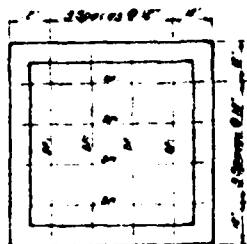
ANTI-SEEP COLLAR
(For Locations, See Sheet No. 4)



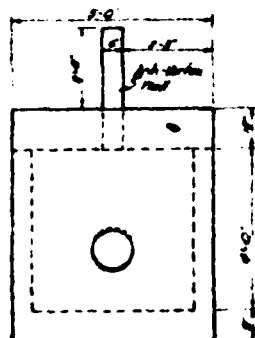
PLAN-00



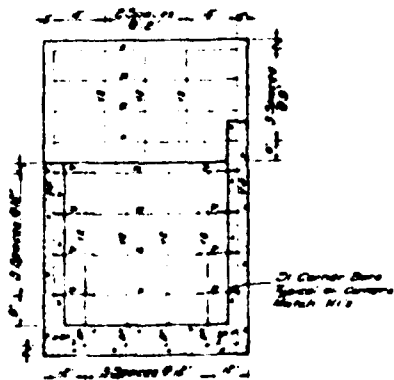
SECTION A-A



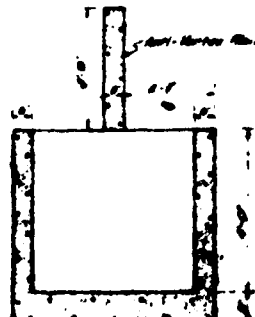
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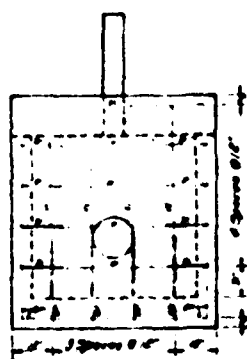
SECTION B-B



SECTION A-A

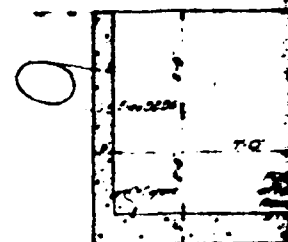


SECTION C-C

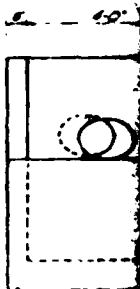


SECTION B-B

On Center Line
Section B-B



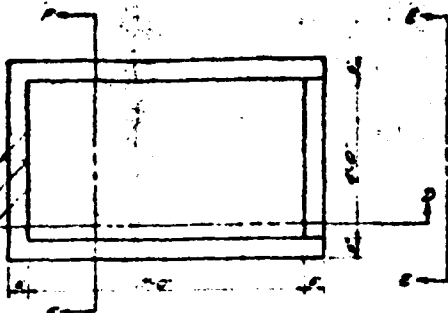
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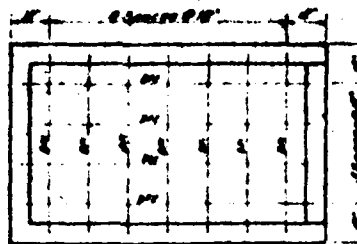
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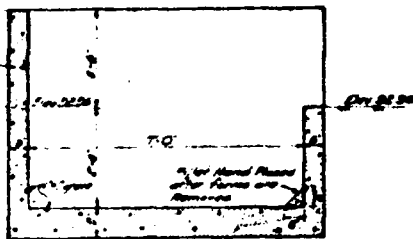
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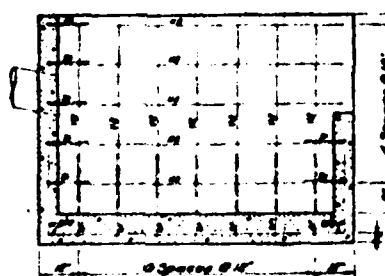
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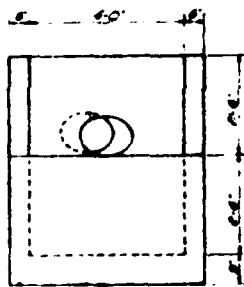
PLAN-OUTLET



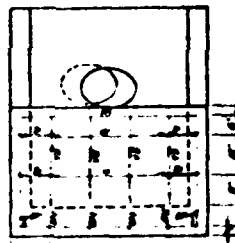
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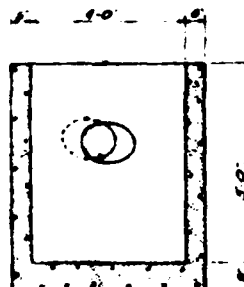
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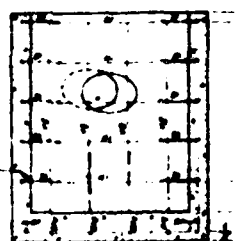
SECTION E-E



SECTION E-E



SECTION F-F



SECTION F-F

REINFORCING BAR BILL							
Both Structures							
Bar	Size	No. Bars	A	B	C	D	Notes
INLET STRUCTURE							
BP1	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP2	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP3	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP4	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP5	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP6	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP7	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP8	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
OUTLET STRUCTURE							
BP1	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP2	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP3	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP4	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP5	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP6	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP7	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
BP8	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	
ANTI-SLEEP COLLARS							
BP1	#4	8	10'-0"	10'-0"	10'-0"	10'-0"	

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QUANTITIES	
INLET STRUCTURE	
Class 2 Concrete	8.4 Cu Yds
Reinforcing Steel	17.1 Lbs
Re. Rod	10 Cu Yds
OUTLET STRUCTURE	
Class 2 Concrete	8.4 Cu Yds
Reinforcing Steel	17.1 Lbs
Re. Rod	10 Cu Yds
ANTI-SLEEP COLLARS	
Class 2 Concrete	1.0 Cu Yds (8 Collars)
Reinforcing Steel	3.4 Lbs (8 Collars)
Re. Rod	1.0 Cu Yds
TOTAL QUANTITIES	
Class 2 Concrete	17.8 Cu Yds
Reinforcing Steel	37.6 Lbs
Re. Rod	20 Cu Yds

*Includes foot, rail and fittings, and details for each corner and corner bar.
*Includes all necessary fittings required for corner installation.

Sheet 3 Appendix A

ROUGH PARK LAKE
JEFFERSON CITY PARK BOARD
JEFFERSON CITY, MISSOURI

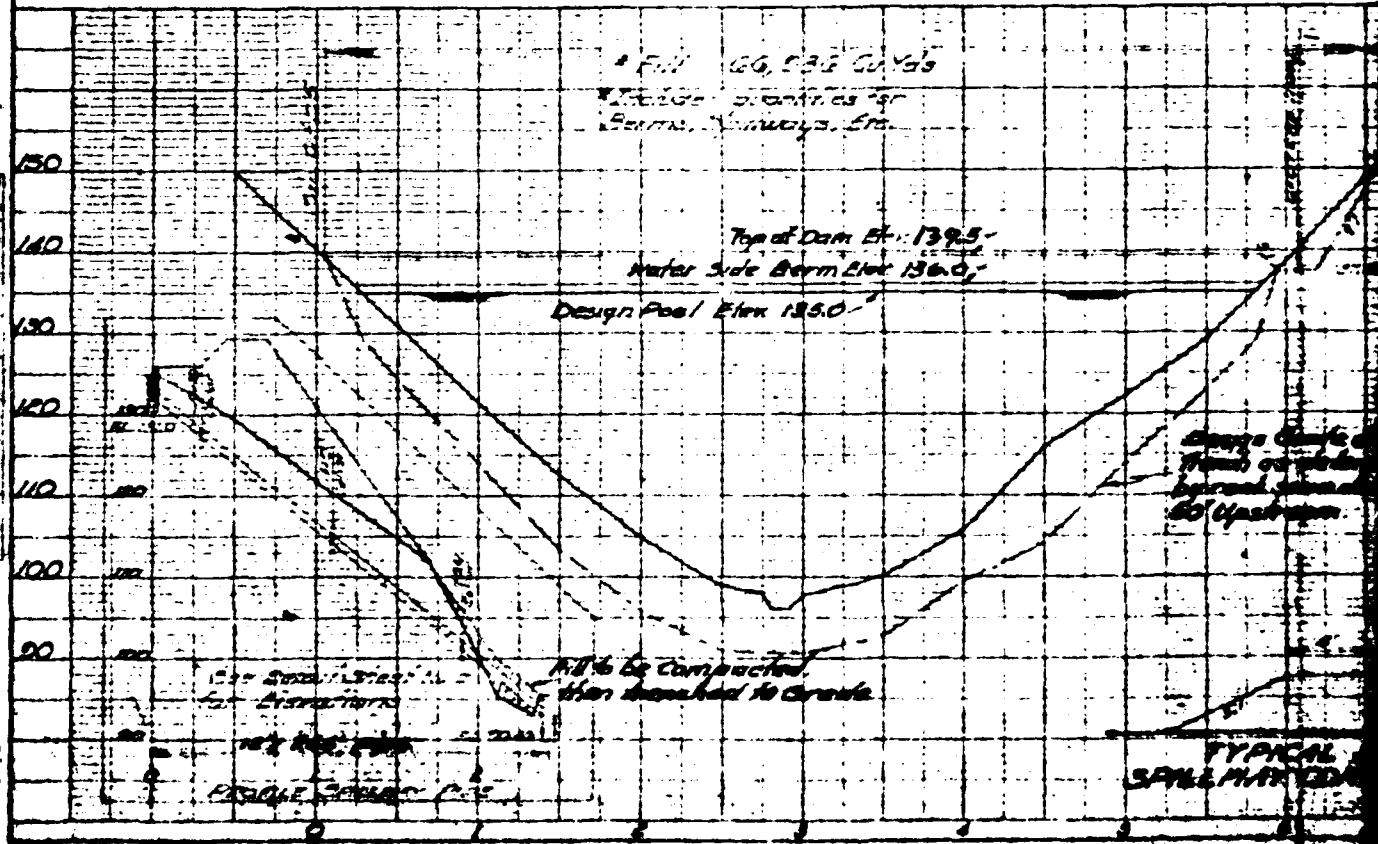
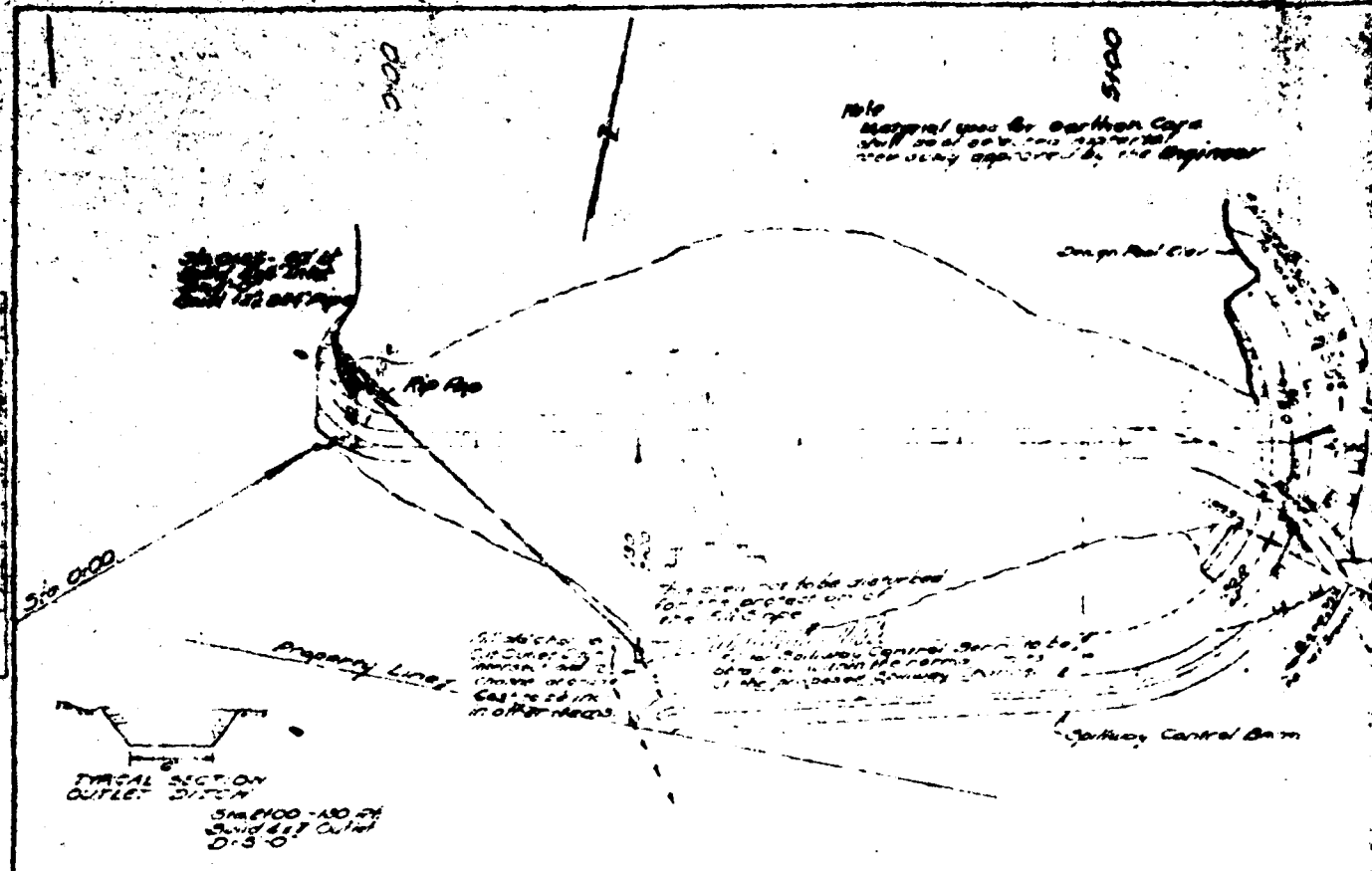
DETAILS SPILLWAY STRUCTURES

RS Thomas Consulting Engineer
Jefferson City, Missouri

Date: 1-24-64 Scale: 1"=4' No. of Sheets: 3

NO.	DATE	BY	REVISION
1	10/1/50	J. S. [illegible]	Initial Design
2	10/1/50	J. S. [illegible]	Revised Design
3	10/1/50	J. S. [illegible]	Final Design

NO.	DATE	BY	REVISION
1	10/1/50	J. S. [illegible]	Initial Design
2	10/1/50	J. S. [illegible]	Revised Design
3	10/1/50	J. S. [illegible]	Final Design



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APPENDIX B

Wm. W. Brown & Co.

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is not removed, water seepage via these weathered openings may reduce the lake level below that which is desired. Therefore, particular attention should be given to the removal of all weathered fragments of dolomite so that the earthen core can be compacted onto fresh, firm, tightly bedded rock.

Auger borings along the center line of the dam as well as upstream in the lake area indicate that the soil cover is relatively shallow with an average thickness of 6 feet. However, a thicker cover of soil may exist along the eastern flank of the valley slope where remnants of a valley terrace are present. Borrow for the dam site can be obtained within the lake area inasmuch as the Jefferson City bedrock appears relatively watertight. However, if it is possible, at least one foot of relatively watertight clay should be left over the bedrock.

In an overall estimate of the lake site the bedrock is ideal from the standpoint of water impoundment. However, this is judged only from field observations inasmuch as test holes were not drilled into bedrock or pressure testing was not performed. Therefore, while it is considered a suitable geologic setting for a lake site, one must remember that water impoundment in an area underlain by bedrock does imply some hazards even though a failure may be remote.

James H. Williams
Missouri Geological Survey
November 4, 1963

AUGER HOLES AT THE JEFFERSON CITY PARK BOARD LAKE SITE

Hole 0 plus 00:

0 - 2': Loam, silt, yellow brown, dry and floury.
2' - 5'3": Loam, clay, brown, dry and firm. Hole bottomed at 5'3" on dolomite.

Hole 1 plus 00:

0 - 3'6": Loam, silt, yellow brown, floury and dry.
3'6" - 6'4": Loam, clay, yellow brown, firm and dry. Moisture increase at 4 feet but below optimum. Hole bottomed at 6'4" on dolomite.

Hole 2 plus 00:

0 - 3'6": Loam, silt, yellow brown, floury and dry.
3'6" - 5': Clay, silty, yellow brown, moisture below optimum, firm. Boulders at 5 feet. Sample taken at 4 foot depth.
5' - 7': Loam, clay, with chert fragments, yellow brown, firm.
7' - 9'6": Loam, clay, yellow brown, firm, moisture increase but below optimum. Material similar to 4 foot sample. Hole bottomed at 9'6" on dolomite.

Hole 3 plus 00:

0 - 4': Loam, gravel with chert boulders, loose, permeable, low density.
4' - 6'4": Sandy clay loam, dark brown, moisture below optimum but not excessively dry. Scattered boulders. Moisture increase to optimum at 2 feet above bedrock. Hole bottomed on dolomite at 6'4".

Hole 3 plus 50:

0 - 4': Loam, gravel, with chert boulder concentration at 4 feet, loose, low density.
4' - 6'3": Sandy clay loam. Hole bottomed at 6'3" on sandstone.

Hole Pot:

0' - 4': Loam, silt, yellow brown, floury and dry. Boulder at 3'6". Hole bottomed at 4 feet on dolomite.

Hole 4 plus 50: Located on nose of terrace.

0 - 3'6":	Loam, silt, floury and dry.
3'6" - 9'6":	Clay, brown, firm and dry.
9'6" - 11':	Loam, clay, gravelly, brown and firm. Sampled at 10'.
11' - 13':	Clay, dark red, firm, moisture increased to slightly below optimum, fat. Sampled from bottom of auger at 13'. Bottomed at 13 feet on dolomite.

Hole 5 plus 50:

0 - 3'6":	Clay, brown, gravelly, with angular chert fragments.
3'6" - 5'1":	Loam, clay, gravelly, with chert boulders. Sampled at 4 feet. Bottomed at 5 feet 1 inch on dolomite.

Following 3 holes are borrow auger prospects, all borrow holes were located at approximately 25 feet in elevation above the valley floor at the dam site. Borrow holes were drilled in a line along the western valley slope and extend to about 500 feet upstream from the center line.

Borrow Hole A: approximately 150 feet north of center line on western valley slope, and 25 feet elevation above station 3 plus 00.

0 - 2':	Silt, light brown, floury and dry.
2' - 4':	Clay, silty, brown, firm and dry. Sampled at 4 feet.
4' - 7':	Clay, silty, brown, firm, slight moisture increase. Boulder at 6 feet. Sampled at 7 feet. Bottomed at 7 feet on dolomite.

Borrow Hole B: located on western valley slope 25 feet elevation above station 3 plus 00 and 330 feet north of center line.

0 - 2':	Loam, silty, yellow brown, dry and floury.
2' - 4':	Clay, silty, brown, firm and dry. Boulder at 4 feet. Sampled at 4 feet.
4' - 5'0":	Clay, gravelly with chert. Bottomed at 5 feet 8 inches on dolomite.

Borrow Hole C: located on western valley slope 25 feet elevation above station 3 plus 00 and 480 feet north of center line.

0 - 2':	Loam, silty, yellow brown floury and dry.
2' - 6':	Clay, silty, brown, dry and firm. Boulder at 4 feet. Sampled at 4 feet. Hole bottomed at 6 feet on dolomite.

James H. Williams
Missouri Geological Survey
November 4, 1963

1/24/67
C. J. 2021
S. 200

TECHNICAL SPECIFICATION NO. 1
EARTHWORK

DESCRIPTION:

Earthwork shall consist of all clearing and grubbing, and hedge removal required for construction and development, excavation for roadway and drainage ditches, emergency spillways, borrow pits, all structures, excavation for placing primary spillway boxes and pipes, excavation for core trenches, earth fills, sub-grade preparation, finishing and all work hereinafter set forth.

CLEARING:

1-1. GENERAL : Clearing shall consist of the removal to the ground surface of all trees, down timber, stumps, snags, and any other woody material having a diameter of three (3) inches or more. Except that some large trees shall be left in place as directed by the engineer. The engineer will clearly mark the trees to be left in place. The diameter of standing trees will be measured at eighteen (18) inches above the ground.

The contractor shall clear the lakebed below elevation 135.00 except for trees selected by the engineer to remain standing. Other miscellaneous clearing as required for construction, or as specified by the engineer, may be necessary. Safe clearing and disposal methods shall be used to prevent damage to trees left in place, and all other privately owned, or publicly owned property. The products of the clearing shall be piled and burned, or buried with at least one foot of cover. Unburned and partially burned debris shall be buried. All holes resulting from the removal of trees or stumps, shall be filled and the ground leveled.

1-2. CLEARING FOR STRUCTURES: Clearing for structures shall be as in Paragraph 1-1, except that all brush and trees shall be removed regardless of diameter. Products from the operation of clearing for structures shall be disposed of as set out in Paragraph 1-1, or as noted on the plans.

1-3. METHOD OF MEASUREMENT: Areas to be cleared shall be as set out in these specifications, as shown on the drawings, or as required by the engineer. General clearing and clearing for structures will not be separated for payment under this contract; but the area indicated for clearing shall include both items.

1-4. BASIS OF PAYMENT: Payment will be made under; Item 1-A CLEARING ; Lump Sum.

GRUBBING

1-5. DESCRIPTION: Grubbing shall consist of the removal and disposal of all stumps, three (3) inches in diameter or more; roots of one (1) inch diameter or more; and partly buried logs or other woody material of comparable size, to a depth of three (3) feet below the natural ground line in areas where structures are to be constructed, or to a depth of one (1) foot below the natural ground line in other areas.

Grubbing shall be performed between slope stakes for cuts and embankments, and on areas designated as borrow pits; but only to the extent noted on the plans or as specified by the engineer. Products from the grubbing operation shall be disposed of as outlined in Clearing Specification 1-1, or as noted on the plans. All holes resulting from the grubbing operations shall be filled and the ground leveled.

1-6. METHOD OF MEASUREMENT: Areas to be grubbed shall be as indicated on the drawings or as required by the engineer.

1-7. BASIS OF PAYMENT: No direct payment will be made for this item, but shall be considered as included in the price bid for other items.

EARTHFILL

1-8. DESCRIPTION: Work covered by this specification consists of performing all the excavation, placing and other operations in connection with the construction of: Embankments for earthfills, as shown on the plans, as herein specified and as directed by the engineer. For these specifications, the term embankment shall mean the earthfill portion of a dam, the back-fill portion of the core trench, road fills, or any other fills so designated.

1-9. MATERIAL: Material for earthfills shall be obtained from borrow pits within the lakebed, core trenches, channel changes, and roadway cuts. Material must be suitable and approved by the engineer during excavation. Material must be free from sod, roots, brush, stones over two (2) inches in diameter, where compacted by hand or mechanical tamper, stones over six (6) inches in diameter where compacted by sheeps-foot roller, and from any other objectionable material which in the opinion of the engineer will not produce the desired compaction. Frozen materials shall not be placed in the fill, nor shall the fill materials be placed on a frozen foundation.

Borrow pits within the lakebed shall be confined to that area lying between elevation 100.0 and elevation 135.0. The contractor will be required to leave eighteen (18) inches of earth overburden over all rock within the lakebed. Slopes of borrow areas within the lakebed shall not slope more than one and one-half horizontal to one vertical between elevation 130.0 and elevation 135.0.

Excavation from the core trench, emergency spillway, and drainage ditches, if considered suitable shall be used in forming embankments as directed by the engineer. Material used for filling the excavated core trench, shall be selected from the most desirable material available as directed by the engineer.

1-10. PREPARATION OF FOUNDATIONS: The area upon which earthfill will be placed shall be stripped of all vegetation, roots, sod, or any other objectionable material to a depth of approximately twelve (12) inches.

The foundation for the core trench shall be prepared with extreme care and caution. The contractor will be required to remove all weathered fragments of dolomite or rock, so that the earthen core can be compacted unto fresh,

firm, tightly bedded rock. The contractor will be required to obtain the approval of the engineer for all prepared foundations, prior to the time of placement of any earthen materials within the core trench or other earthfills.

Material stripped from the embankment area shall be stock piled and used to spread on the slopes of embankments or cuts, as a dressing or top soil. Areas to be stripped must be well disked before the stripping operation. Disking shall be carried out to the extent necessary to cut up sod or other vegetable matter, so as to prevent balling up when spread, and permit the placing and finishing of a reasonably uniform layer on slopes or other surfaces as designated on the plans, or directed by the engineer. A part of this strip material may also be used for filling old channels and etc., if specified on the plans or directed by the engineer. Material to be used for dressing shall be stock piled by the contractor where, and in any manner acceptable to the engineer.

After stripping processes have been completed and just prior to placing fill material, except in core; the foundation area shall be scarified, plowed, or broken up to a depth of approximately six (6) inches. Any unsuitable material exposed by this operation, such as sand or muck deposits, shall be removed and disposed of as directed by the engineer. Cost of preparing the foundation as outlined above, and disposal of strip material as noted or as shown on the plans shall be included in the price bid for earthfill.

1-11. PLACING AND SPREADING MATERIAL: The placing and spreading of fill material shall be started at the lowest part of the section under construction; unless otherwise authorized by the engineer. And the fill carried up in horizontal layers of not over eight (8) inches in thickness. Where possible, these layers shall extend over the full area of the fill. The distribution and gradation of materials throughout the fill shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Earth fills shall not be placed against a slope that is steeper than one horizontal to one vertical, except as shown on the plans, or as specified by the engineer.

Sufficient work shall be performed on the top, side slopes, and berms of embankments, so that such slopes will be left in a neat and workman like condition, true to limits, lines and elevations shown on the plans. Borrow pits above pool elevation, if any, must be left in a workman like condition, free to drain, with back slopes not steeper than two and one-half horizontal to one vertical, smooth and uniform. Embankments should be free to drain during the stages of construction.

Equipment driveways on fill which may become smooth and hard during fill construction, may be ordered scarified before additional material is placed on same, if considered necessary by the engineer.

1-12. **COMPACTION:** The contractor shall furnish and operate the necessary types and kinds of equipment to perform the operations required to obtain the compaction specified herein, for all earthfills placed in the construction processes under this contract. The equipment shall be in good working order and shall be of the capacity, weight, and/or power necessary to perform the required operations in a workman like manner and produce satisfactory progress in construction. After each layer of fill material has been placed, spread and contains the required moisture content specified, it shall be compacted by passing the necessary equipment over the entire surface of the layer a sufficient number of times to obtain not less than eighty five percent (85%) of maximum dry density.)

Densities of compacted fill will be determined by comparing field density, to density obtained by compacting the same type of soil in a laboratory by modified proctor test. In no case shall the field density be less than eighty five percent (85%) of the maximum dry density.

1-13. **METHOD OF MEASUREMENT:** Measurement of quantities for payment will be computed from the plotted cross sections shown in the plans, are from actual sections taken at the completion of fill as determined by the engineer. Cross section areas will be computed from a plane twelve (12) inches below the original ground, in order to allow for replacement of the materials required to be removed during stripping operations. Volume of earth fill in cubic yards will be determined by the average end area method.

The end area shall include the area of the core trench, as shown on the plans, and back fill required to fill the core trench will be considered as earth fill. If during construction, it is considered advisable by the engineer, to either lower or raise the grade line of the core trench from that shown on the plans; end areas will be adjusted accordingly on the basis of a ten (10) foot bottom, and side slopes of one vertical to one horizontal. The core trench will not be cross sectioned before being back filled and the volume of material required to fill the core trench will be computed from the cross sections on the above described section at the final grade as established by the engineer for the core trench.

1-14. **BASIS OF PAYMENT:** Payment will be made at the contract price, per cubic yard for earth fill in place, and shall include all fill required to replace that area, required to be stripped in the preparation of the foundation, dam site fill and core trench fill, but shall not include approach fills or back fills made necessary by additional excavation made by the contractor for his own convenience. Payment will be made under Item 1-B; Earth fill, per cubic yard.

TECHNICAL SPECIFICATION NO. 2
PLAIN AND REINFORCED CONCRETE

2-1. DESCRIPTION: The work covered by this specification includes the furnishing of all material, except as may be otherwise provided in the contract; equipment, labor, mixing facilities, constructing forms, transporting, placing concrete and reinforcing steel, finishing, curing, removal of forms, etc.

MATERIALS;

2-2 CEMENT: Cement used shall be Portland Cement, which shall conform to A.S.T.M. serial designation C-150, type 1 cement. Type 3 cement shall be used when high early strength is desired. If plans specify Air Entrain Cement, it shall conform to all requirements of A.S.T.M., serial designation C-175, for type B cement.

2-3. CONCRETE AGGREGATES: Concrete aggregates shall meet Missouri State Highway Department Specifications for Class B Concrete. Contractor must notify the engineer in writing before placing any concrete, the source from which he expects to secure above aggregates.

2-4. WATER: Water used in mixing concrete shall be clean and free from deleterious amounts of acids, alkalis or organic materials, and shall be approved by the engineer.

2-5. PREMOLDED JOINT FILLER: (A) Self-expanding cork; This material shall be nonextruding resilient preformed expansion joint filler. Material shall consist of clean granulated cork particles securely bound together by an insoluble synthetic resin, meeting A.S.T.M. specification type 2, as manufactured by Servicised Products Corporation, 6051 West 65th Street, Chicago 38, Illinois, or its equivalent.

(B) Asphalt Joint Filler: This material shall consist of a composition of asphalt and vegetable fiber, formed between two sheets of asphalt, saturated felt paper, as manufactured by Servicised Products Corporation, or its equivalent.

(C). Joint seal: This material shall be hot-poured rubberized asphalt joint sealing compound that forms a resilient, adhesive and effective plastic and maintains bond at 0°F. Joint seal material shall be hot-poured paraffin plastic as manufactured by Servicised Products Corporation, or its equivalent.

Cost of joint filler and seal materials completely installed in joints, as indicated in specifications and as shown on the plans shall be included in the unit price bid for other items.

2-6. METAL REINFORCEMENT: (A) Metal reinforcement shall conform to the requirements of the Standard Specifications for Billet Steel Concrete Reinforcement Bars, A.S.T.M. serial designation A15-39, or for Standard Specifications for Rail Steel Concrete Reinforcement Bars, A.S.T.M. serial designation A16-35, or for Standard Specifications for Axle Steel Concrete Reinforcement Bars, A.S.T.M. serial designation A160-39.

(B). Welded Wire fabric or cold-drawn wire for concrete reinforcement shall conform to the requirements of the Standard Specifications for Cold-

drawn Steel Wire Concrete Reinforcement, A.S.T.M., serial designation A82-34, or Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement, A.S.T.M., serial designation A185-37.

2-7. Cements, aggregates, and reinforcing steels shall be stored at the work in such a manner as to prevent deterioration or intrusion of foreign matter. Any material which has deteriorated or which has been damaged shall not be used in the construction of this project.

2-8. CONCRETE QUALITY: The working stresses for design structures are based on the specified minimum ultimate 28-day compressive strength of the concrete. The minimum ultimate 28-day compressive strength of concrete used on this project shall not be less than 3,000 pounds per square inch.

2-9. CONCRETE PROPORTIONS, PLACEMENT, ETC.: The water cement ratio, the proportions and consistency of, the methods of placement, and all other details of concrete used in this project shall meet the requirements of the Standard Specifications of the Missouri State Highway Commission, Edition of 1961 for Class B Concrete.

2-10. TEST: If requested by the engineer, compression test specimens shall be made during construction in accordance with the Standard Method of Making and Curing Compression and Flexure Test Specimens in the Field, A.S.T.M. serial designation C31-44. Each test shall consist of two specimens.

2-11. CLEANING AND BENDING REINFORCING STEEL: Metal reinforcement at the time concrete is placed shall be free from rust scale or other coatings that would destroy or reduce the bond. Bars shall be bent cold as indicated by bending sketches on the plans, and if not indicated by bending sketches, bends shall be in accordance with Standard Practice.

2-12. PLACING REINFORCEMENT: Metal reinforcement shall be accurately placed in accordance with the plans, and shall be adequately secured in position by use of wire ties, concrete blocks, or metal chairs and spacers. If concrete blocks are used for supporting reinforcement, they shall be precast to thickness required, using mortar of the same proportions to be used in the concrete and damp-cured for at least five days before using. Dimensions shown on the plans from outside face of concrete are to center-line of bar.

2-13. SPLICING REINFORCEMENT: All reinforcing bars shall be spliced at exact points indicated on plans and lap of splice shall be not less than thirty-two (32) times the diameter of the bar spliced, or thirty-two (32) times the diameter of the smaller bar. Bar splices at points of critical stress in tension will not be permitted and any revision in location of splices must be approved by the engineer.

2-15. CONSTRUCTION JOINTS: Construction joints shall be located in accordance with the plans, and keys provided as noted. Construction joints not shown on the plans, must be approved by the engineer, however no construction joints will be allowed at points of critical shear unless provided for. Before continuing next pour, construction joints shall be thoroughly cleaned of laitance and other foreign material and well wetted just before commencing pour. At least two (2) hours must elapse after depositing

concrete in columns or walls before depositing in beams, girders or slabs supported thereon, will be permitted.

2-16. EXPANSION JOINTS: Expansion joints shall be located in accordance with the plans, and thickness of expansion material as specified.

Expansion material shall be stitched to one face of the concrete with copper wire to prevent displacement after completion. For bevels and finish at joint, see plan details.

2-17. BASIS OF PAYMENT: (A) Payment for reinforced concrete pavement as specified in the spillway area, will be paid for under Item 2-A; Spillway Pavement Reinforced, per square yard.

(B) Payment for concrete in all inlet and outlet structures, and anti-seed collars will be paid for under Item 2-B; Class B Concrete, per cubic yard. Payment for reinforcing bars required in the construction of all inlet and outlet structures, and anti-seed collars will be paid for under Item 2-C; Reinforcing Steel, per pound.

TECHNICAL SPECIFICATION NO.3
GALVANIZED CORRUGATED METAL PIPE

3-1. DESCRIPTION: This item consists of sections of pipe plain or coated, with or without diaphragms, tees, elbows, gates or other fixtures as noted on the plans. Laid on a firm bed with properly fitted joints and covered or back filled, and compacted to not less than ninety percent (90%) of maximum dry density. Corrugated metal pipe must meet the requirement of the Missouri State Highway Department Specification.

3-2. LAYING PIPE: Pipe, or pipe and fixtures shall be carefully laid or placed, true to lines, grades and position, as shown on the plans, or as directed by the engineer. Outside laps of circumferential pipe joints shall point upstream, and pipe shall be placed so that longitudinal laps are on the sides. Pipe shall be joined in the field by butting together and placing water tight coupling bands, as hereafter noted. Gauge, size of pipe, sequence of placing sections, type and fixtures shall be as noted on the plans.

3-3. FORMING BED FOR PIPE: Trench shall be excavated to the required depth and the bottom of the trench shall be shaped to conform to the bottom of the pipe for at least ten percent (10%) of its overall height, and shall afford a uniformly firm bed throughout the bearing length. If rock is encountered, the trench shall be excavated six (6) inches below the bottom of the pipe and back filled to grade with suitable material thoroughly tamped and shaped. Any soft or yielding material encountered in forming pipe bed must be removed and replaced with suitable material, well compacted and approved by the engineer. In areas where the pipe is to be placed through or unto a fill, this fill must be placed at least twelve (12) inches above the top of the pipe, and then trenched and the bed for the pipe formed.

3-4. COUPLING BANDS: Coupling bands shall be of the same material and gauge as the pipe to be joined. The width of the bands will be not less than twelve (12) inches. The bands will be placed with a gasket or other material as required to make a water tight joint, after completion of joining the pipe with the coupling bands. Flat head rivets must be used in the pipe under water tight bands.

3-5. METHOD OF MEASUREMENT: Measurement of corrugated metal pipe, complete in place, with all required bands, trenching and backfilling will be made to the nearest foot, measuring along the centerline of the pipe.

3-6. PAYMENT FOR PIPE COMPLETE IN PLACE: Including coupling bands and all other appurtenances will be made under Item 3-A; Twelve Inch Corrugated Metal Pipe, per lineal foot.

TECHNICAL SPECIFICATION NO. 4
FURNISHING AND PLACING RIP RAP

4-1. DESCRIPTION: Rip rap shall consist of constructing a protecting blanket of rock or broken concrete, in areas indicated on the plans.

4-2. MATERIALS: The material for rip rap shall be durable stone or broken concrete, containing a combined total of not more than ten (10) percent of earth, sand, shale and non-durable rock. It is preferable that the material contain a large percentage of pieces as large as the thickness of the blanket will permit, with enough smaller pieces of various sizes to fill the larger voids. At least fifty (50) percent of the mass shall be of pieces having a volume of one-half cubic foot or more.

4-3. The material shall be obtained, hauled and deposited in areas indicated on the plans. The rock or broken concrete, shall be placed to the prescribed thickness, elevation and extent indicated on the plans, and manipulated so that most of the flat sides are in contact; thereby eliminating large voids. The outside of the rip rap shall present an appearance free from segregation and without a proportionate amount of the larger pieces showing.

4-4. METHOD OF MEASUREMENT: Measurement will be made to the nearest cubic yards of material in place, at the completion of the rip rap.

4-5. BASIS OF PAYMENT: Payment for all materials, equipment and labor necessary to furnish and place rip rap, will be paid for under Item 4-A; Furnishing and Placing Rip Rap, per cubic yard.

TECHNICAL SPECIFICATION NO. 5
TRASH BARRIER

5-1. DESCRIPTION: This item of work shall consist of furnishing all materials, labor, equipment, fittings, etc., as may be required to properly construct a trash barrier in accordance with the plans at the locations indicated. Both workmanship and materials shall be free from defect and constructed so as to properly perform the function desired.

5-2. MATERIALS:

(A). Corner posts shall be 2 1/2 inches in diameter x 6 feet 0 inches galvanized pipe with cap set in two (2) feet of concrete. The concrete shall have a diameter of not less than fifteen (15) inches. Posts shall be constructed in such a manner as to allow for the proper fastening of the wire fabric and top rail.

(B). Line posts shall be two (2) inches in diameter x 6 feet- 0 inches galvanized pipe with loop cap at front, and sides. The line posts shall be set two (2) feet into the ground. Post shall provide for the proper attachment of the wire fabric and top rail.

(C). The top rail shall be 1 5/8 inches in diameter galvanized pipe of the length required by the plans. The top rail shall have all the necessary fitting to permit attachment to the corner posts and line posts as indicated on the plans.

(D). The wire fabric portion of the trash barrier shall be nine (9) gauge chain link galvanized fabric fence, forty-eight (48) inches high. The contractor shall be required to furnish all ties, railend fittings, end bands, tension bands and tension required for the proper construction of the trash barrier.

5-3. BASIS OF PAYMENT: Trash barrier, including all materials, equipment, labor and related appurtenances shall be paid for , complete in place, under Item 5-A, Trash Barrier, Lump Sum.



Missouri Conservation Commission

Highway 50 West

Telephone 636-8141

Jefferson City, Missouri 65102

WILLIAM E. TOWELL, Director

December 10, 1963

Season's Greetings

COMMISSIONERS

ART H. BURCH
Maryville

R. TWEDIE, SR.
Jefferson City

BEN CASH
Kennett

RU L. PIPPIN
Waynesville

Mr. Howard E. Scott, Director
Parks and Recreation
Jefferson City Park Board
1203 West Dunklin
Jefferson City, Missouri

Dear Mr. Scott:

For the lake we have been discussing in Hough Park of 11 acres, with an 83 acre watershed, the total volume of runoff from a 1 in 50 year storm would be approximately 28 acre-feet.

I don't have the storage capacity figures for this lake, but a 28 acre-feet flood would raise the lake level above the spillway crest 2 to 3 feet. I would suggest that you use a 3 foot crest in this case. In addition, you should have a 25 foot emergency dirt spillway cut in one of the abutments. The emergency spillway crest could have a crest at 3 feet above the main spillway crest.

In addition, the main spillway could be sized to drain the 28 acre-feet flood in 2 days - this would be a sustained flow of approximately 69 c.f.s. thru the spillway.

I would suggest that you plan on a total of a 5 foot freeboard above the main spillway crest which would allow a 50 year storm to be stored, plus an additional 2 foot emergency freeboard for flow thru the dirt spillway.

Sincerely,

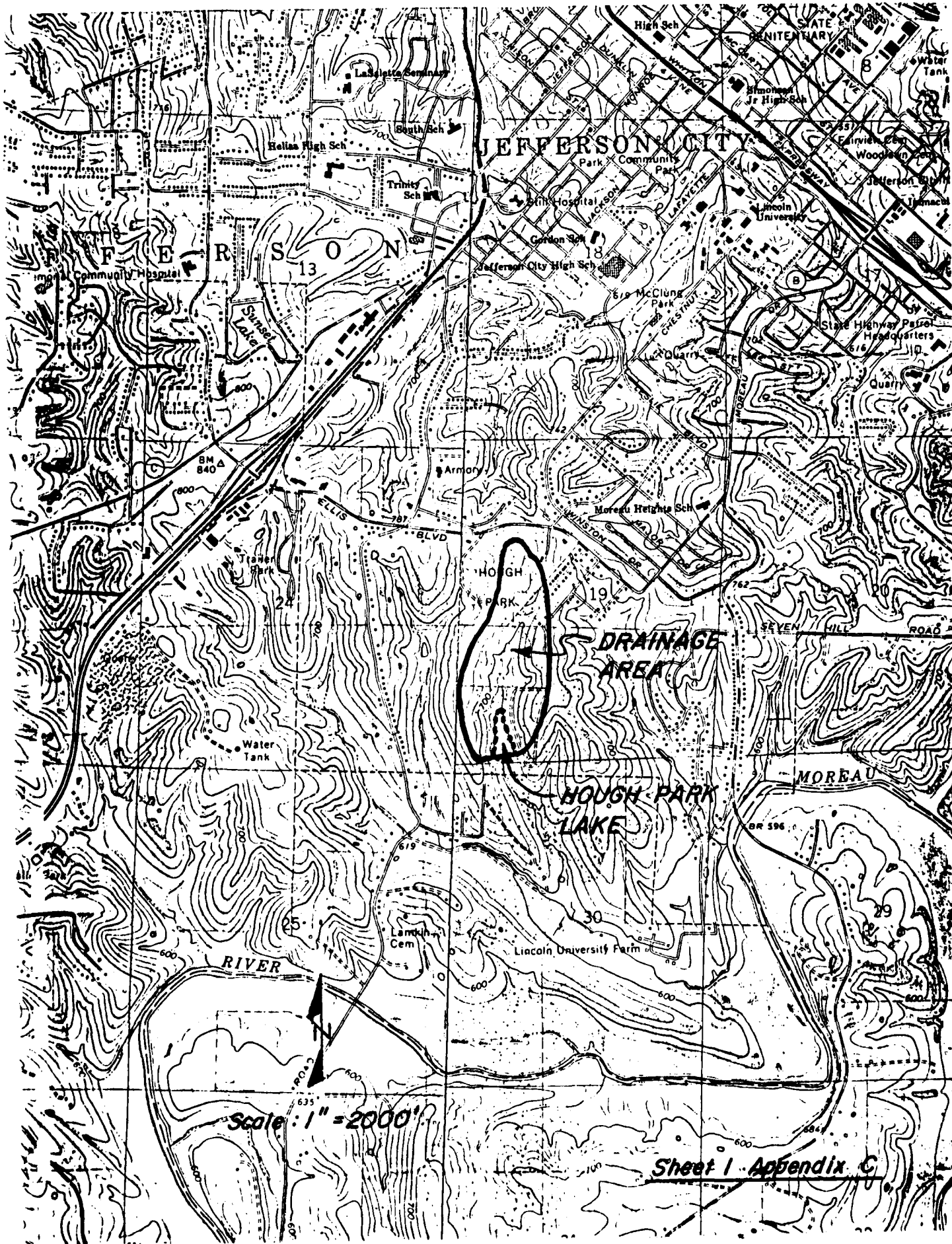
Charles E. Hooker, Jr.
Chief Engineer

CEH:ss
cc: William E. Towell

Sheet 15
Appendix B

DEC 11 1963

APPENDIX C



HYDRAULICS AND HYDROLOGIC DATA

Design Data: From Contract Drawings

Experience Data: No records are available. The caretaker stated that the lake had difficulty filling, and water is pumped from a well to supplement the runoff. The apparent high water mark is about 2.0 ft above primary spillway elevation (135.0 ft). The caretaker doesn't recall water ever flowing over the emergency spillway.

Visual Inspection: At the time of inspection, the pool level was about at normal pool (elev. 135.0).

Overtopping Potential: Flood routings were performed to determine the overtopping potential. Since the dam is of intermediate size with a high hazard rating, a spillway design storm of 100 percent PMF was prescribed by the guidelines. The watershed drainage area was obtained by planimeter from U.S.G.S. 7.5 minute Jefferson City, MO quadrangle map. The reservoir surface area was obtained by planimentering the reservoir layout on construction plans. The storage volume was developed from this data.

A 5 minute interval unit graph was developed for the watershed which resulted in a peak inflow of 362 c.f.s. and a time to peak of 10 minutes. Application of the probable maximum rainfall, minus losses, resulted in a flood hydrograph peak inflow of 1769 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411.

Considering all factors, the combination of dam, spillway and storage is not sufficient to pass the PMF without overtopping the embankment. The crest elevation of 139.5 ft would be overtopped by 0.68 ft at flood pool elevation 140.18 ft.

Fifty percent of the PMF was routed through the spillway and reached a pool elevation of 139.63 ft, which is 0.13 ft above the crest. The portion of the PMF that will just reach the top of dam is about 47 percent, which is greater than the 100-year flood event. For additional information, see the Summary of Dam Safety Analyses on Sheets 3 and 4.

OVERTOPPING ANALYSIS FOR Hough Park Dam

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
Hydraulic Inputs Are As Follows:
 - a. Twenty-four Hour Rainfall of 25 Inches For 200 Square Miles - All Season Envelope
 - b. Drainage Area = 90 Acres; = 0.14 Sq. Miles
 - c. Travel Time of Runoff 0.24 Hrs.; Lag Time 0.14 Hrs.
 - d. Soil Conservation Service Runoff Curve No. 80 (AMC III)
 - e. Proportion of Drainage Basin Impervious 0.13
2. Spillways
 - a. Rating Curve for Primary Spillway: By Hanson Engineers

 - b. Emergency Spillway
Length 28 Ft.; Side Slopes 3:1; C = 2.65
 - c. Dam Overflow
Length 585 Ft.; Side Slopes Vertical C = 3.0

Note: Combined Spillway and Dam Rating Data Provided To Computer on Y4 and Y5 Cards.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph
 - a. Peak - 362 c.f.s.
 - b. Time to Peak 10 Min.
2. Flood Routings Were Computed by the Modified Puls Method
 - a. Peak Inflow (see Sheet 6)
50% PMF 884 c.f.s.; 100% PMF 1769 c.f.s.

b. Peak Elevation

50% PMF 139.63 100% PMF 140.18

c. Portion of PMF That Will Reach Top of Dam

47 %; Top of Dam Elev. 139.5 Ft.

3. Computer Input and Output Data Sheets 5 and 6

HOUGH PARK DAM (MAXIMUM PROBABLE FLOOD) IN PAGE 0001

HOUGH PARK DAM (MAXIMUM PROBABLE FLOOD) INPUT DATA

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A      OVERTOPPING ANALYSIS FOR HOUGH PARK DAM (NO 6) (HEC-1) DAM SAFETY
A      CO. CODE: 051 CO. NAME: COLE STATE ID NO. MO 30022 GWR. JEFF. CITY PA
A      HANSON ENGINEERS INC DAM SAFETY INSPECTION (JOB NO. 03778)
B      300
B1     5
J      1      8      1
J1     0.10    0.20    0.30    0.40    0.50    0.70    0.80    1.00
K      0      1      0      0      1
K1     INFLOW HYDROGRAPH COMPUTATION
M      1      2      0.14    0.14    1
P      0      25     102     120     130
-      -1      -30
W2     0.24    0.144
X      0      -1      2
K      1      2      1
F1     RESERVOIR ROUTING BY MODIFIED PULS AT HOUGH PARK DAM
Y      1      1      1
Y1     1
Y4     135     137.5    138.5    139.5    140.5    141.5    143.5    145.5    149.5
Y5     0      8      90     264     2191    5822    15843    28923    62561
$G     126     139     151     164     177     183     221     259
$E     135     136     137     138     139     139.5    142.5    145.5
$F     135
$D     139.5
K      99
  
```

2

0 (HEC-1) DAM SAFETY
022 GWR. JEFF. CITY PARK BD
SECTION (JOB NO. 03778)

0.80 1.00
1

-90

0 13

1
PARK DAM

126	-1	
43.5	145.5	149.5
5843	28923	62561
221	259	
42.5	145.5	

Sheet 5 Appendix C

PAGE 0001

HOUGH PARK DAM (MAXIMUM PROBABLE FLOOD) OUTPUT DATA

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS
AREA IN SQUARE MILES (SQUARE KILOMETER

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED			
				RATIO 1	RATIO 2	RATIO 3	RATIO 4
				0.10	0.20	0.30	0.40
HYDROGRAPH AT	1	0.14	1	177.	354.	531.	708.
	(	0.36)	(	5.01)	10.02)	15.03)	20.04)
ROUTED TO	2	0.14	1	5.	38.	95.	211.
	(	0.36)	(	0.15)	1.08)	2.68)	6.54)

SUMMARY OF DAM SAFETY ANAL

PLAN 1	ELEVATION	INITIAL VALUE	SPILLWAY CRES
	STORAGE	135.00	135.00
	OUTFLOW	126.	125.
		0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS
0.10	136.60	0.00	146.	5.
0.20	137.87	0.00	162.	38.
0.30	138.53	0.00	171.	93.
0.40	139.22	0.00	180.	215.
0.50	139.63	0.13	185.	511.
0.70	139.92	0.42	188.	1067.
0.80	140.01	0.51	189.	1251.
1.00	140.18	0.68	192.	1572.

2

SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 CFS PER SECOND (CUBIC FEET PER SECOND)
 SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
0.20	0.30	0.40	0.50	0.70	0.80	1.00
354.	531.	707.	884.	1238.	1415.	1769.
10.02)(	15.03)(	20.03)(	25.04)(	35.06)(	40.07)(	50.08)
38.	95.	215.	511.	1067.	1251.	1572.
1.09)(	2.68)(	6.09)(	14.47)(	30.21)(	35.43)(	44.51)

SUMMARY OF DAM SAFETY ANALYSIS

TOTAL VALUE	SPILLWAY CREST	TOP OF DAM
135.00	135.00	139.50
126.	126.	183.
0.	0.	264.

UN H AM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0	146.	5.	0.00	19.58	0.00
0	162.	38.	0.00	18.17	0.00
0	171.	95.	0.00	17.08	0.00
0	180.	215.	0.00	16.08	0.00
3	185.	511.	0.42	15.92	0.00
2	188.	1067.	0.83	15.75	0.00
1	189.	1251.	1.00	15.75	0.00
8	192.	1572.	2.58	15.75	0.00

APPENDIX D



Aerial View of Lake and Watershed



Aerial View of Dam



View of Crest Looking West (Emergency Spillway in Foreground)



Downstream Face of Dam



Approach - Emergency Spillway



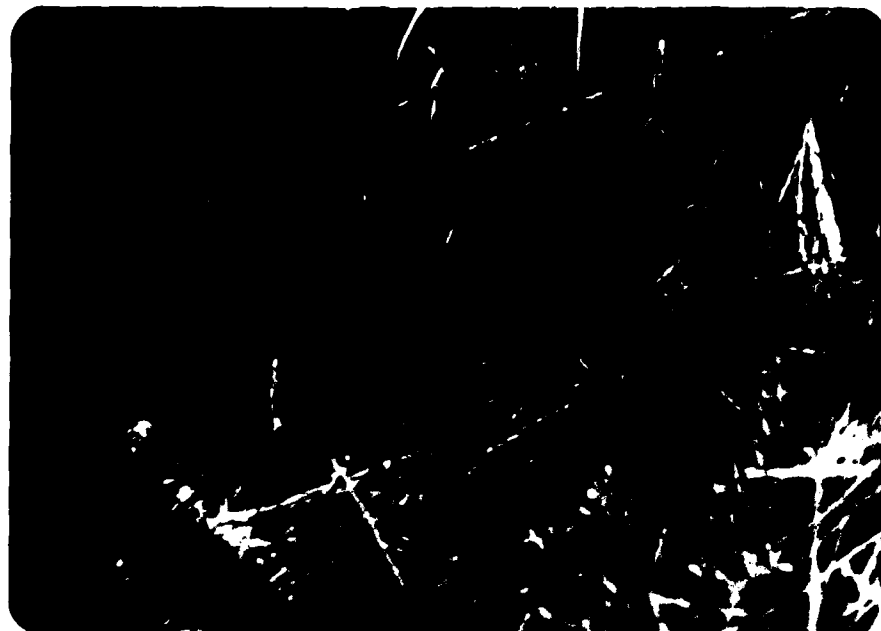
Emergency Spillway - Looking Downstream



Primary Spillway - West Abutment



Primary Spillway and Outflow Pipe



Seepage - Downstream Slope



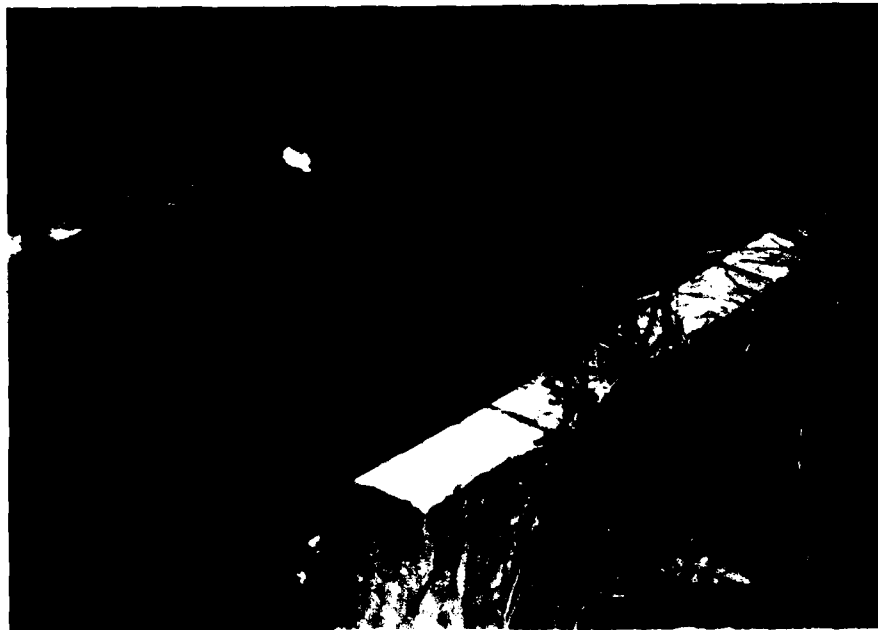
Seepage - Downstream Slope



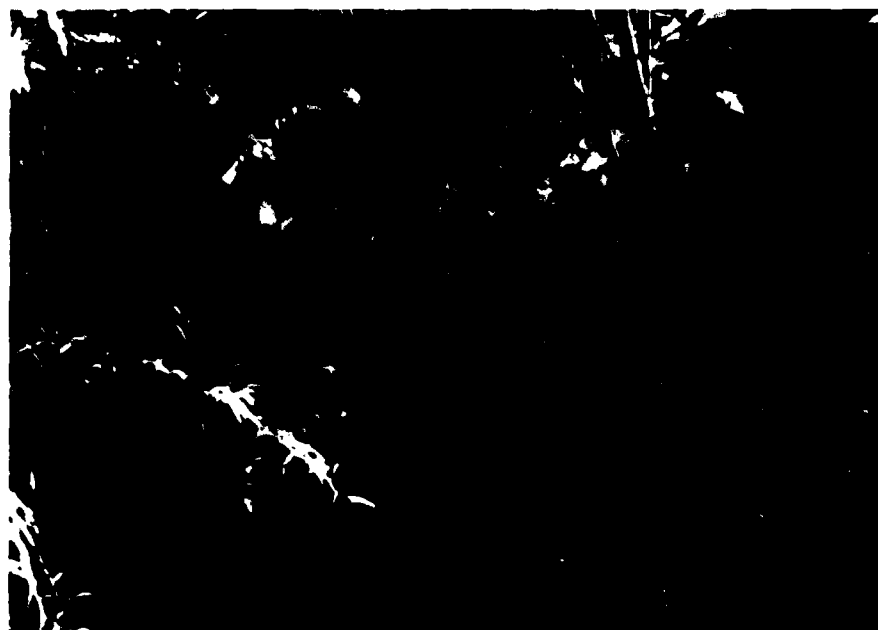
Upstream Face of Dam



View of Lake From Dam



Primary Spillway Outlet Structure



Primary Spillway Outlet Area